

Fuelling NZ's future with smart catalysts

New collaboration combines chemistry and engineering

In February of this year, a group of leading scientists and engineers from the US, Spain, Switzerland, Canada and New Zealand gathered at the University of Otago. They had been invited there by MacDiarmid Institute Principal Investigator, Professor Sally Brooker, to talk about future 'green' fuels. Timed to precede AMN9 (see page xx), the inaugural Otago Future Fuels (OFF) workshop featured expert tutorials, student talks and poster sessions. "It was designed primarily as a training programme for postgrads working in this area," says MacDiarmid Principal Investigator and University of Otago Professor Brooker. "Students met with, and learnt from, an amazing group of international superstars. And it also gave staff like me the opportunity to hear about their latest research." The event was such a success that Brooker will run another one (OFF-2) to tie in with AMN10.

Combining chemistry and engineering

One of the speakers at OFF was another member of the MacDiarmid Institute, Associate Professor Aaron Marshall from the University of Canterbury. He is an engineer whose research centres on materials development for a range of energy applications, and like Professor Brooker, he's fascinated by catalysts. The pair met two years ago at a MacDiarmid Institute event, and after hearing about his

work, Professor Brooker invited Associate Professor Marshall to give a departmental seminar. "I was just so impressed," she says. "Not only by what Aaron was doing, but also his ability to communicate engineering to a chemistry audience. That visit also enabled us to have some key conversations, and cemented the idea in both our minds that if we combined our efforts, we could achieve something really exciting."

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Since then, they've been busy building a collaboration that combines their skills in synthetic chemistry and materials engineering. PhD students and postgrads from each group are starting to work together, and despite having offers from overseas, Professor Brooker choose to stay in NZ for her 2019 sabbatical, so she could be based at Canterbury with Associate Professor Marshall.

Designing fuels less harmful to the environment

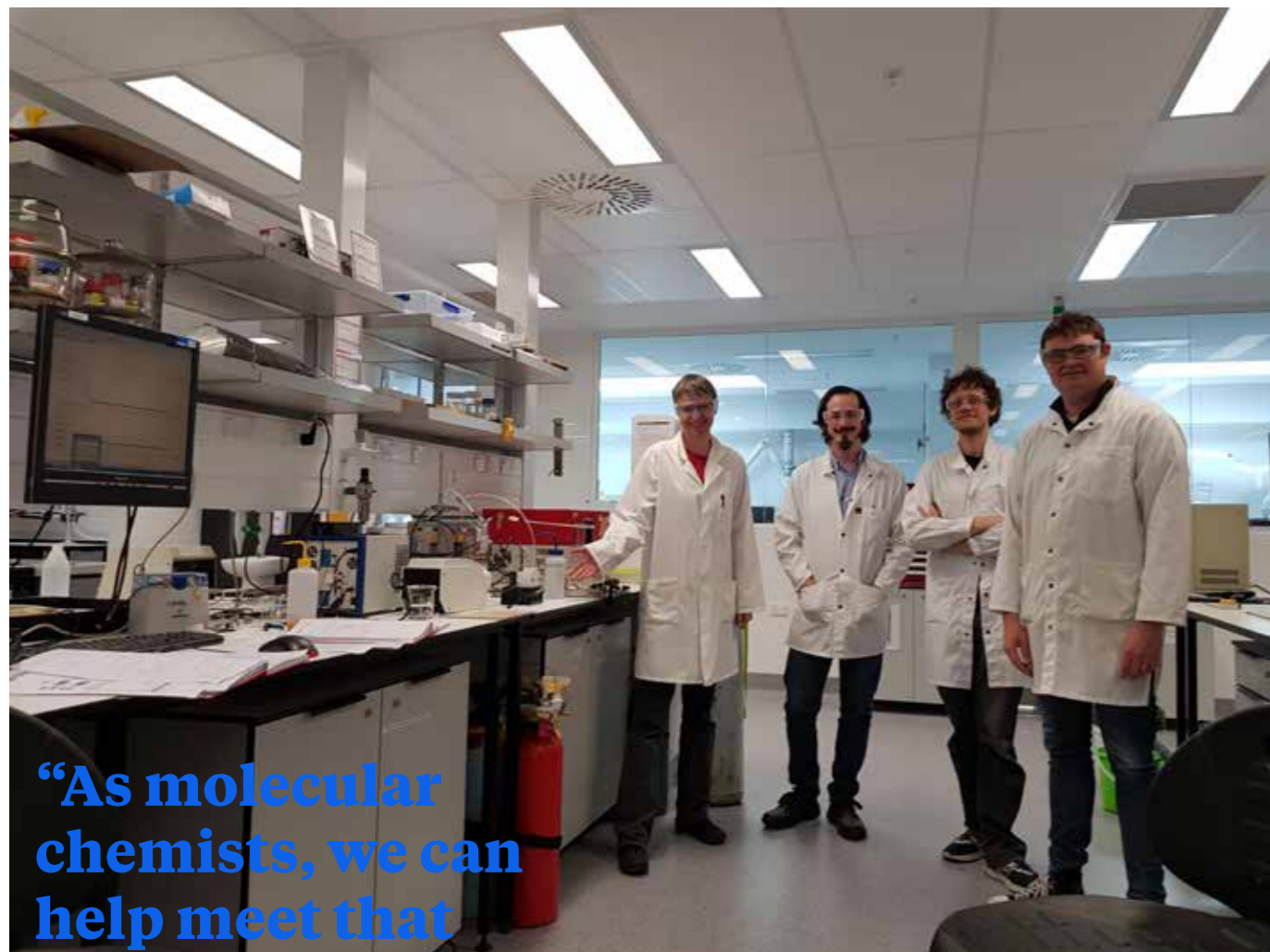
Their goal is to design a new generation of catalysts that could make tomorrow's fuels less harmful to the environment. One topic they're exploring is extracting hydrogen gas from water. As well as being an area of shared expertise, it also forms the basis of another of Professor Brooker's key collaborations

– with Professor Garry Hanan at the University of Montreal. "Garry and I published a paper on the performance of some cobalt compounds – we made the catalysts here at Otago, and Garry tested them under photocatalytic conditions in his lab. They worked very well." Professor Brooker continues, "And now, by working with Aaron, we'll be able to explore how those compounds perform in an electrocatalytic set-up." Thanks to a Catalyst seed grant with Professor Hanan, Professor Brooker is also bringing new, hands-on knowledge to NZ. "Two of my PhD students, Abdullah and Fola, have spent extended periods in Montreal, learning how Garry's photocatalytic system works and collecting lots of data on our complexes. Rather than starting to build up a system like Garry's from scratch in Dunedin, the plan is to modify the system Aaron has to enable it to do photocatalytic testing too."

CO₂ to fuel

Alongside their hydrogen work, Professor Brooker and Associate Professor Marshall will also develop catalysts for the production of commodity chemicals from carbon dioxide. "I think this is where we could potentially add the greatest value," she says, "There's a selectivity challenge with CO₂ reduction, because of the vast number of potential products. As molecular chemists, we can help meet that challenge, and potentially find a way to turn CO₂ into a liquid fuel, like methanol."

Both hydrogen generation and CO₂ reduction are of growing importance to the NZ energy landscape. In Taranaki, Hiringa Energy is working to generate hydrogen fuel for the heavy transport sector using wind



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power. And the nearby Methanex plant generates 2.4 million tonnes of methanol a year. So, supported by the MacDiarmid Institute, Professor Brooker and Associate Professor Marshall recently visited the region, to explore the potential industrial implications of their work. Professor Brooker says that she found the meetings with the team at Venture Taranaki to be “... really invigorating. They have such a positive can-do attitude, and they’re pushing to build this much greener future. It’s exciting.” She plans to stay in close contact, and Hiringa Energy have agreed to be part of her advisory board on grant applications. But, Professor Brooker says, they’re not thinking too far ahead just yet, “In

catalysis, you can get things badly wrong if you’re not careful, so we’re taking the time to set all this up and test our protocols properly. We want to build a robust and reliable testing system. That way, when we have our ‘eureka’ moment, we can really enjoy it.”

“Growing up on a farm, I’ve always loved nature and been very keen on doing things to help the planet. If we can make catalysts that can genuinely contribute to either carbon zero fuels like hydrogen, or carbon neutral fuels like methanol, then I’ll be very happy.”

